Project Title: In Situ Ferrous Iron Reactive Zone for Treatment of Cr(VI) and Other Reducible Contaminants

Investigators: Ralph Ludwig, Chunming Su, Steven Acree, Randall Ross, Frank Beck, Patrick Clark, Kyle Jones

Problem Definition: Zero valent iron in the form of iron filings has to date been the most commonly used PRB media for treatment of reducible metals (e.g. hexavalent chromium) and chlorinated hydrocarbons (e.g. TCE). Although effective, the installation of iron filings based PRBs can be costly particularly at depths greater than 30 ft. In addition, iron-filings based PRB systems are rigid systems that offer limited flexibility with respect to installation design and post-installation refinement. Alternative PRB systems may be warranted in cases where installation of zero valent PRB systems are considered too costly or technically challenging due to site-specific conditions in effect.

Background: Ferrous iron is an effective reductant for treatment of contaminants such as hexavalent chromium (Cr(VI)), selenium, and uranium. It also can be effective for treatment of chlorinated hydrocarbons such as TCE under appropriate conditions. Ferrous iron is normally difficult to deliver into the subsurface due to its tendency to rapidly precipitate out of solution. This normally results in injection well and aquifer formation clogging. However, in the presence of a reducing agent such as sodium hydrosulfite, the ferrous iron can be stabilized in solution for an extended period of time to allow for its effective dissemination within the subsurface. This allows for development of a ferrous iron rich reactive zone within the subsurface capable of treating reducible dissolved phase contaminants originating from up-gradient sources. The injected ferrous iron can augment existing natural reserves of reducible aquifer iron in the subsurface by 100-fold or more. This may translate to a 100-fold or more increase in treatment longevity relative to ferrous iron based PRB systems generated through injection of a reductant (e.g. sodium hydrosulfite) alone.

Objectives: The objectives of the study are to determine whether ferrous iron in the presence of sodium hydrosulfite can be effectively disseminated within a Cr(VI) impacted aquifer, whether it can be injected without adversely impacting the hydraulic conductivity of the aquifer formation, and whether the injected ferrous iron can effectively form a reactive barrier capable of treating incoming dissolved phase Cr(VI) and selenium.

Approach: Ferrous iron was injected in combination with sodium hydrosulfite into a native aquifer formation in the path of a dissolved phase Cr(VI) plume at the Macalloy Corporation site in Charleston, S.C. Transects consisting of 1-inch diameter monitoring wells were installed up-gradient, within, and down-gradient of the injection wells. Groundwater samples are being analyzed for multiple parameters including cations, anions, ORP, pH, conductivity, and ferrous iron. Comparison of data up-gradient, within, and down-gradient of injection points will be used to evaluate performance of the ferrous iron based treatment systems. Hydraulic conductivity testing within the ferrous iron reactive zone will be used to evaluate hydraulic conductivity changes, if any, over time.

Accomplishments to Date: Injection of ferrous iron in the presence of sodium hydrosulfite has thus far (over a one year period and five pore volumes of treatment) been shown to be effective in treating the dissolved phase Cr(VI) and selenium to non-detectable concentrations.

Near Future Tasks: Groundwater monitoring will be continued over an additional two year period to further evaluate the performance and longevity of the ferrous iron reactive zone.